The Novice Dabbles—In Boats

THE MODEL ENGINEER

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In this issue

MODELS AS AN AID TO TRAINING

The fighter pilot must be able to recognise instantly an enemy aircraft that he has never seen before, and, in addition, he must know the " blind spot " of that particular aircraft, so that he may attack in the most favourable direction. His training, therefore, includes the study of silhouettes of enemy aircraft, and the careful examination of scale models from all possible positions. This picture shows pilots studying models of, left to right, an M.E. 109 Messerschmidt, a Junkers 87, a Heinkel III, and a Junkers 52.

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60 Kingsway, London, W.C.2

Smoke Rings

Wireless Control Experiments

READERS who have been engaged on experiments with the wireless control of model boats or aeroplanes should note that this is now prohibited except under a special permit from the Postmaster-General. This prohibition also covers the possession of apparatus for this purpose, even though it may not be in use, unless an official permit is obtained. Any reader having apparatus of this kind in his possession should communicate, without delay, with the Engineer-in-Chief, G.P.O. Radio Branch (W.2/1), Harrogate, Yorks.

* * *

A Model Engineers' "Question Bee."

THE Norwich Society of Model Engineers has taken a leaf out of the book of the B.B.C. and staged a "question bee" for the entertainment of its members. At a recent meeting two teams were formed, with loco. men on one side and non-loco. men on the other. Questions on model making and general engineering matters were then submitted to each side in turn, and four points were awarded if the question was answered correctly within 30 seconds. Each side had to answer 16 questions, and at the finish it proved that the loco. men had won by a small margin of points. This is a bright idea which, well managed, should provide a very instructive evening, and is well worthy of emulation by other societies desiring to add a note of novelty to their indoor meetings.

* * *

Model-car Racing

THE new sport of model-car racing has caught on in the United States like the proverbial house on fire. A number of clubs have been formed, special racing tracks have been built, and crowds of spectators attend the meetings. At one track a wire-netting barrier had to be erected all round to keep off the invasion of children and dogs while racing is taking place. This is a new element of protection which speed-boat enthusiasts have not so far needed. One club has 30 cars in its membership, and another has 40. These range from cars with engines of 10 c.c. capacity down to what is called the "Pee-Wee" class of .36 cu. in. capacity or less. At one meeting held in very cold weather, it is reported that "several of the cars were frost-bitten and had to be returned to their blankets." The humorous bent of the minds of some of the enthusiasts is revealed in the title of one of the most successful clubs. It is named the "Valley Wheel-twisters Club." This club has a public attendance of from 400 to 700 at its Sunday afternoon race-meetings. They have a circular running track 1/16th of a mile in circumference, banked at an angle of 40 degrees. It is now being improved by a crash-wall round the embankment, a lawn in the centre circle, a starting table, and an electric-eye timing device. Meanwhile, supply firms have come into being with offers of engines, car bodies, wheels, and all the accessories which the new sport needs. It seems set fair for big development.

* * *

The "M.E." Overseas in War-time

IN an interesting letter from Mr. W. E. Phillips, of Sarnia, Ontario, Canada, there are many gratifying remarks, which, however, serve to show just what THE MODEL ENGINEER means to its readers in the Dominion. Mr. Phillips writes: "Each week or so, I have proof that Britannia still rules the waves, as my copy of THE MODEL ENGINEER *arrives*. True, I sometimes get two copies at once, but the main thing is I get them . . . I am getting a lot of fun and information out of the war-time issues; first, the tremendous volume of practical material, more than I can absorb, but which will be put on file for reference. The other point is the sly digs at a man called Hitler and his friends (or is it 'fiends'?). The juxtaposition of the cartoon, 'By the right—Scuttle,' and the scene at a power-boat regatta in England is priceless. By reading between the lines, I can form a better opinon of how England looks at the war."

The tribute to the British Navy will be echoed by all our readers, but especially by those who live overseas, few of whom are not receiving their MODEL ENGINEER almost as regularly as in peacetime. And let it be said that there are many readers whose present daily toil consists in helping in the regular delivery of THE MODEL ENGINEER to overseas fellow enthusiasts; the number of our readers who are in the Navy and the two other Fighting Forces is remarkable, and this small acknowledgment of their faithful services is only too readily given. Our heartfelt good wishes go out to them all. And we know of some who are occupying their very scanty leisure in making models of some sort out of anything that can be pressed into such a service! At a not-too-distant date—let us hope—some descriptions and illustrations of " models made on Active Service " will find a place in the pages of the " M.E."

But, to return to Mr. Phillips' letter, we believe the cartoon and photograph referred to tickled the fancy of most of our readers; a little harmless fun does us all some good in these difficult days. Incidentally, Mr. Phillips has sent us a fine photograph of the Canadian National Railways 4-8-4 type locomotive, No. 6400, at the head of the Royal Train; we hope to publish this picture, presently.

* * *

Engineers in Sea Warfare

EVERYONE knows the important part which is being played by engineering on the home front, but it is sometimes forgotten that the skill of the engineer plays a more intimate and active part in war manœuvres, not only in the field and in the air, but also on the high seas. The marine engineer, in particular, is rarely in the limelight. but always well and truly on the spot. An account appeared recently in the newspapers of how an armed trawler chased and eventually sunk a U-boat, and it is interesting to note that this brilliant feat of British seamanship was only possible through the resource of the engineer officer, who succeeded in forcing the ship's engines up to such a speed as was certainly never contemplated in their design. It is stated that a speed of 18 knots was attained by the trawler, which was probably designed to do about 14 or 15 knots at most; and this speed was maintained to the end in spite of the fact that vibration was so bad that the engines were shifted bodily on their foundations. This story bears a special significance for model engineers, many of whom have spent a good deal of time in coaxing the very last ounce, and a little more, out of an engine. It may never have occurred to them that this enterprise may possibly constitute excellent training for such an eventuality as above described. These readers will fully realise how much extra power is required to drive a boat at about 25 per cent in excess of normal speed, and will be able to visualise the scene in the engine-room and stokehold of a ship in which the feat is achieved. Incidentally, it may be mentioned that a member of THE MODEL ENGINEER staff experienced a somewhat similar adventure in the boiler-room of a battle cruiser in the battle of Jutland. This particular ship had never previously attained more than 25 knots, but succeeded on this occasion in keeping battle formation at over 28½ knots; surely a tribute to the physical and mental endurance of the " black squad," battened down below hatches in a blistering inferno of heat, smoke and steam. But even when super speed for purposes of offence or defence is not required, a great deal depends on the skill and care of the ship's engineer, and the man who is capable of handling marine engines competently is well equipped to tackle most engineering problems he may encounter on land. Even in model engineering, the construction and handling of marine plant calls for the greatest skill and initiative, and the pride of the model power-boat enthusiast in the achievement of successful and reliable running is thus seen to be adequately justified, besides symbolising an ancient tradition of a seafaring race.

* * *

The Internal-Combustion-Engine-driven Locomotive

DURING the preparation of the design and description of the proposed " MODEL ENGINEER Internal-Combustion-Engine-driven Locomotive," the question has arisen as to whether there is some apt and, at the same time, properly descriptive substitute for that cumbersome title! The new model is, as already announced, to be driven by a petrol engine; but the term " Petrol-engined Locomotive " does not seem to be quite satisfactory, although it conveys a meaning that would be readily understood by most people, and is fairly descriptive of the general arrangement of the model. Perhaps, some of our readers would like to think this matter over and make some suggestions. The prototype is known as a Diesel locomotive; but, in this instance, the term "Diesel " does not seem to be correct, since the engines do not operate strictly in accordance with the principles laid down by Diesel himself. A true Diesel engine is one in which the ignition pressure and compression pressure are about equal to each other. In common parlance, however, the term " Diesel " is applied to almost any compression-ignition engine, which is not correct; it is one of those examples of everyday speech that reveal the average Englishman's ignorance of his own language! But, to return to the point, something better than " Petrol-driven Locomotive," seems desirable as a substitute for "Petrol-engined Locomotive."

Percival Marshall

*The Novice Dabbles—In Boats

An account of a newcomer to the model world, who, but for this war and the blackout, might still have been a sceptic in the land of the uninitiated

By R. J. Gibbs

AFTER reading my last article, I realised just how little I told of my method of building model boats. But then, as a beginner, I attempted only to inspire the novice like myself.

My latest ship—steam-driven—is 25 in. long, has a beam of 6 in., and draws under an inch of water. Her weight loaded is about $3\frac{3}{4}$ lb. and she is as flat-bottomed as her predecessors. As I told you, I designed my own work based on a (very) few principles culled from my handbook. The two chief points are (1) the weight, and (2) the proposed length—approximately, of course. As water has an accepted weight (I don't attempt to prove it, and make no apology for my scientific negligence) of a lb. for every 27 cu. in., and, as I'd estimated my boat to weight $3\frac{1}{2}$ lb., the space it would occupy in water would naturally be nearly 95 cu. in.

**Continued from page* 331, "*M.E.*," *March* 28, 1940.

At this point I should like to explain away a mathematical term. It is called by Those Who Know, the "Block Coefficient," and only means in English the relation of the water displaced, to a box having the same overall dimensions

In boats of fair width I read, this ratio is about .7, which means that 95 cu. in. is 7/10 of the length, $\times$ breadth (or beam), $\times$ depth (or draft).

To calculate these last two measurements we multiply 95 $\times$ 10/7 and divide by our length, which was agreed at 25 in. The area of the mid-section, then, is $5\frac{1}{2}$ sq. in., and when divided by the beam of 6 in. shows why she draws under 1 in. of water. You choose the most suitable beam to accommodate the engine and to look well at the same time, and don't forget my advice about erring on the wide side, as this lowers the centre of gravity and makes for safety.

This is the only calculation I indulged in, and

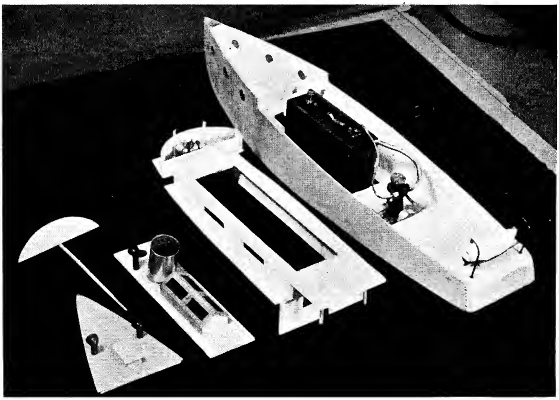


Photo by] **" The assembling of the units is a simple operation."** [*Leon Isaacs*

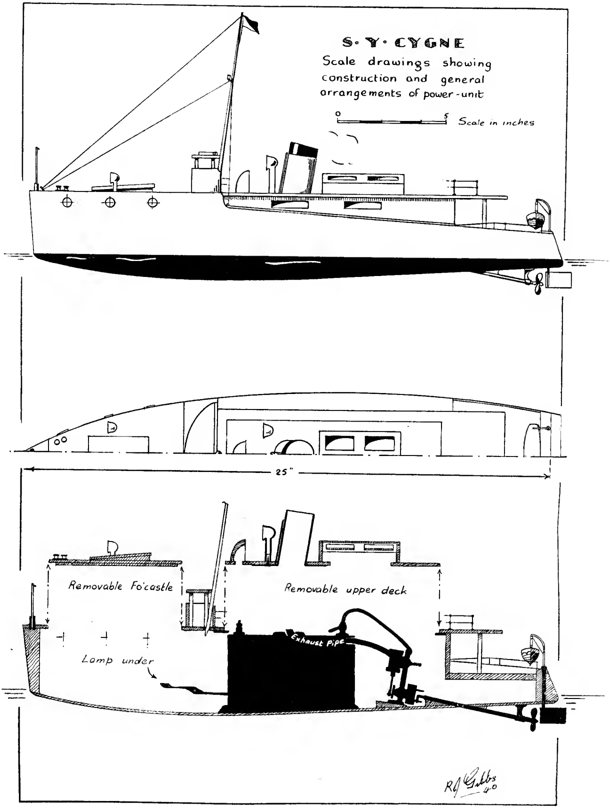

S· Y· CYGNE
Scale drawings showing construction and general arrangements of power-unit
0
5
Scale in inches
25"
Removable Fo'castle
Removable upper deck
Exhaust Pipe
Lamp under
R J Gibbs 40

Photo by] **" After pinning together she looks decidedly ship-shape."** [*Leon Isaacs*

the slight headache I suffered after weeding out this data from my reluctant and technically-worded handbook was no great sacrifice.

For all other proportions I used a rather elastic scale of about $3\frac{1}{2}$ ft. to the inch. I sketched what I thought the hull would contain in real life, and for the rest, pleased my eye and imagination. I drew my side elevation and half-plan, as shown, actual size so as to trace it direct on to $\frac{1}{8}$ in. three-ply from which I cut sides, bottom, and decks. I found steam best for curving to shape. It is quick —*and* stays put. Just hold the piece over the kitchen kettle and bend it across your thigh. Keep your plan handy to check with and you can't go wrong.

When bent, nail the two sides to the " nose " block (A) and transom (B) (Fig. 3) which have been previously cut from oak, deal, or similar timber.

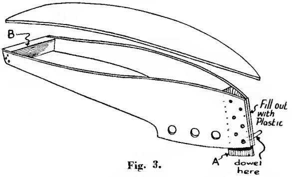


Fig. 3.

Don't nail right home, as these are only temporary while the bottom is fixed with $\frac{3}{8}$ in. brass pins around the edges.

My next move was to drill through the two blocks for the insertion of $\frac{1}{8}$ in. dowel pieces, as shown in my accompanying sketch.

As for caulking, I resorted quite happily and with no experience to plastic wood. My faith was well placed, and as the stuff dried it shrunk snugly into the corners and sealed stone hard.

I put a squeeze round the outside of the joints as well, just to make sure, and sandpapered it smooth when dry.

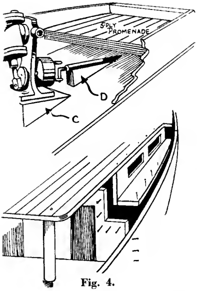


Fig. 4.

The most accurate operation is drilling the hole for the stern tube. I mastered the trick after my second boat by drilling straight instead of attempting to cut obliquely, and opened it up to the required angle with a tiny round file I found in a cocoa-tin beneath the bench.

And here's a tip I found successful. When setting the tube in plastic wood, rub some Seccotine around it and the plastic will take kindlier to the brass.

(To be continued)

Powers for Displacement Hulls

By John Houstoun

SMALL I.C. and steam engines for model power boats can only be judged under service conditions, by their performance. I propose, therefore, to describe a means whereby the power necessary to propel a displacement-type hull at a given speed, may be assessed with reasonable accuracy.

If the weight of any floating object is divided by the product of the length, breadth, and mean draught, we have a value known as the *Block Coefficient*, or Coefficient of Fineness. This is usually expressed as:

$$\frac{\text{Displacement of ship in cu. ft.}}{\text{Length in feet} \times \text{Breadth in feet} \times \text{Mean draught in feet.}}$$

The Displacement in cubic feet being equal to $\frac{\text{weight in lb.}}{62.5}$

There are many rules for determining the approximate wetted surface of a vessel; in our case Denny's rule is perhaps the most convenient to apply.

$$\text{Wetted Surface in square feet} = 1.7\,\text{LD} + \frac{\text{V}}{\text{D}}$$

Where L = length in feet
D = mean draught in feet
and V = under water volume in cu. feet
= Block Coefficient × (L × B × Mean Draught)

If we examine the case of a vessel in motion in water, we find that the resistance to propulsion consists of

(*a*) Eddy making resistance
(*b*) Wave making resistance
(*c*) Frictional resistance

and of these it will only be necessary to consider (*c*) for our purpose.

It has been found experimentally that fluid friction (i) depends on the conditions of the surfaces in contact (ii) is independent of the fluid pressure (iii) varies as the (Velocity)^n (iv) varies as the total immersed area. On examination we find that (i), (iii) and (iv) are important—items (i) and (iii) being interdependent. The value of n is generally taken as 2—a more correct value being 1.83, this value refers to a clean painted surface. As a result of experiment Froude found that a force of 0.25 lb per square ft. of surface is necessary to propel edgeways a sheet of thin plate through water, at a speed of 600 ft./minute. This may be expressed as follows: let V = Velocity in feet per minute, then FrictionForce per square foot at $V = \frac{0.25\,V^2}{(600)^2}$

The scale speed of a model may be determined by means of the formula: $\frac{S}{\sqrt{L}} = \frac{s}{\sqrt{l}}$

where S = speed of full size vessel
L = length of full size vessel
s = speed of model
l = length of model.

In describing the manner in which we make use of the above data, I will refer throughout to my model, M.V. *Jeriston*, of which the following are particulars:

Length—6 ft. ... *Scale*—1/72 or 6 ft. to 1 in.
Breadth—9 in. ... *Speeds*—(*a*) $3\frac{1}{2}$ m.p.h. model, 26 knots (scale)
Mean Draught—$6\frac{3}{4}$ in. ,, (*b*) 4 m.p.h. model, 29 knots (scale)

$$\textit{Block Coefficient}\ \frac{\frac{105}{62.5}}{6 \times 0.75 \times 0.565} = 0.6636$$

$$\text{Wetted Surface} = 1.7 \times 6 \times 0.565 + \frac{\frac{105}{62.5}}{0.565} = 8.76 \text{ sq. feet}$$

$$3\tfrac{1}{2}\text{ m.p.h. (model)} = \frac{3.5 \times 5280}{60} = 308 \text{ feet/minute}$$

$$\left.\begin{matrix}\text{Friction force}\\ \text{per square foot}\end{matrix}\right\} = 1/4 \times \frac{(308^2)}{(600^2)} = 0.66 \text{ lb/sq. foot}$$

$$\text{Total friction force} = (8.76 \times 0.066) = 0.577 \text{ lb.}$$

$$\text{Horse Power} = \frac{0.57 \times 308}{33000} = 0.005387 \text{ H.P.}$$

It must be carefully noted that the horse powers obtained in this manner only refer to the power actually necessary to propel the *hull*. The actual horse power developed by the engine will be considerably greater, as friction and wave-making resistance must be overcome. As models are normally run at considerably in excess of their scale speeds, the wave-making resistance becomes of great importance, and for accurate results must be taken into account.

The thrust in lb. may be obtained from the formula:

Thrust in lb. = 5.67 A × K × k,
where A = Swept Area of propeller in square feet

$$= \frac{11}{14}\left[\left(\begin{matrix}\text{Prop. Dia.}\\ \text{in feet}\end{matrix}\right)^2 - \left(\begin{matrix}\text{Boss Dia.}\\ \text{in feet}\end{matrix}\right)^2\right]$$

K = Theoretical speed in knots

$$= \frac{\text{R.P.M.} \times \text{Pitch in inches} \times 60}{12 \times 6080}$$

k = speed of slip in knots

$$= \left\{\begin{matrix}\text{Theoretical speed} \\ \text{in knots}\end{matrix} - \begin{matrix}\text{Actual speed}\\ \text{in knots}\end{matrix}\right\}$$

care must be taken to ensure that area is in square feet and speed in knots.

From experiments I have made I find the slip with a well-designed and carefully made propeller at speeds up to 6,000 R.P.M. averages 12-15 per cent. This figure was obtained from a displacement hull of special design at speeds of over 20 m.p.h., and I suggest, therefore, for our purpose we can assume a slip of 15 per cent. with reasonable accuracy.

As the above formulae are standard for full-size practice *we cannot expect to obtain true values*, as corrections should be introduced, but we can use the values obtained as a "*basis for comparison.*" In all research work, e.g., Teddington Tank, etc., the requisite corrections are made.

It will be readily understood that hydroplanes cannot be dealt with as I have suggested, as their "wetted surface" is by no means constant. A well-designed hydroplane in motion has (theoretically) point contact with the surface of the water, thereby reducing wetted surface (or fluid friction) and wave-making resistance to a minimum.

An Experimental "Purley Grange"

By "L.B.S.C."

MOST followers of these notes are aware that I just love a bit of experimental locomotive work, and if I build two engines of the same class, they are pretty certain to vary in detail, even if externally identical. Some time ago I started to build a $2\frac{1}{2}$ in. gauge "Purley Grange," and made several departures from the detailed instructions which I gave in the old "Live Steam" notes. The work has been carried on intermittently, as opportunity afforded; but the locomotive, at the time of writing, is nearly complete. As Mr. Grose took several photographs of her in progress, I thought maybe a reproduction of them, with some particulars of the "variations," might prove interesting reading.

Frames and Running Gear

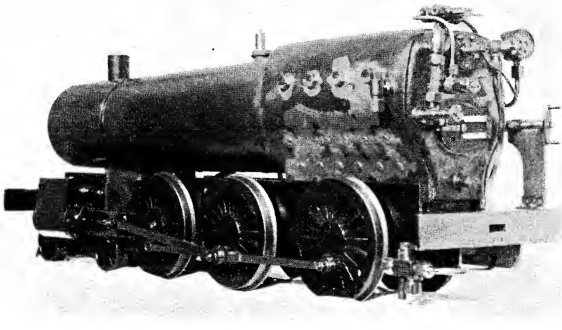
The frames and buffer beams are as specified; but as I happened to have a bit of bronze rod which exactly fitted the Kennion pressed hornblocks, it was utilised, six axleboxes being parted off to length in the four-jaw chuck, and flanges added by silver-soldering a piece of 1/16 in. sheet metal to one side of each, allowing sufficient to project each side, to form the flanges. After cleaning up, the boxes were drilled in the usual way, and erected.

I had a spare feed pump, made at the same time as the one I made for Mr. Grose's "Saint" class G.W.R., and as it had a horizontal instead of inclined barrel, it was placed with the barrel below the leading coupled axle instead of above it. This gave more room for the extra top clack and the bypass union, and made it a little easier to fit up the eccentric and rod. The delivery union can also be placed vertically, and is easily got at from underneath the "works" by using a bent spanner.

Having some wheels in stock which had big bosses, and would finish to 3 in. diameter, it was decided to use "scale" size wheels and cylinders, so the wheels were turned to the equivalent of 5 ft. 8 in., and the holes for the coupling-rod pins drilled a full $\frac{5}{8}$ in. from centre, coupling rods being made and fitted as specified. Four separately adjustable eccentric sheaves were mounted on the driving axle, to operate the valve gear, plus one for the pump.

Cylinders

The cylinders are a little larger than given in the specification, being a full 13/16 in. in the bore, with the longer stroke mentioned above. The steam ports are also larger, the exhaust remaining the same. The valve spindles end at the front of the valves, and have no tail extensions; the glands are longer, but pin-drilled to allow clearance for the valve crossheads. The guide yokes, which also



An experimental $2\frac{1}{2}$ in. gauge "Purley Grange."

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support the pendulum lever bearings, are built up instead of being made from angle.

The Valve Gear

The engine has Stephenson link motion; but instead of the usual launch-type links as used on the full size article, box links are used, similar to those on the "Castles" and other Great Western engines with Walschaerts gear. I have already built several locomotives with launch-type links (have one here now) and wanted to try the effect of connecting the little end of the eccentric-rod, so that it lined up dead with the die blocks in full gear, and gave the equivalent of a direct drive on to the inside pendulum lever, without introducing the "knuckle" effect which always obtains with launch-type links. Incidentally, this also simplified the whole doings, because it eliminated the forked ends to the eccentric rods which are necessary with launch-type links, and also did away with the separate lifting block and pin.

Straps and rods were made in the usual way, the rods being bent to a template, and fitted to the straps on a jig, so that all four were exactly equal in length between centres. The little-end eyes were hardened in "Ecosite" powder. The pins, which were made from the shank ends of worn or broken high-speed No. 40 drills, were screwed a fine pitch and are a tight fit in the tapped holes in the blank side of the links. They will probably last the lifetime of the engine without getting slack! The lower pin is extended to take the end of the lifting link. The upper pin has a countersunk head fitting a recess in the eccentric-rod eye.

How Links Were Made and Erected

The links were machined from $\frac{3}{8}$ in. square steel bar, bent to the approximate radius, and mounted on a piece of brass plate, bolted to the lathe face-plate at the requisite distance from centre, to give correct radius. An ordinary parting tool plus plenty of cutting oil, did the trick. The die blocks were made from $\frac{1}{8}$ in. by 3/16 in. silver steel, as used for guide bars. The links are casehardened, and the die blocks hardened right out. The latter are attached to turned silver-steel pins screwed into the suspension levers. These are much closer to the frame than when launch-type links are employed, consequently the bush in the frame is shorter. The fulcrum pin has a thin hexagon head, and is inserted from the outside. The inclined valve rods connecting the suspension levers to the inside pendulum levers on the rocking shafts, had to be set over a little, to clear the axleboxes. The weighbar shaft, rocking shafts, and connection to the valve-spindle crossheads, are all as specified. As the engine will run on a continuous road, and a fine adjustment for notching-up is more important than a quick reverse, the reversing screw is 2 BA single thread, left-handed. It reverses in sixteen turns, and is operated by a G.W. double-armed lever instead of a wheel.

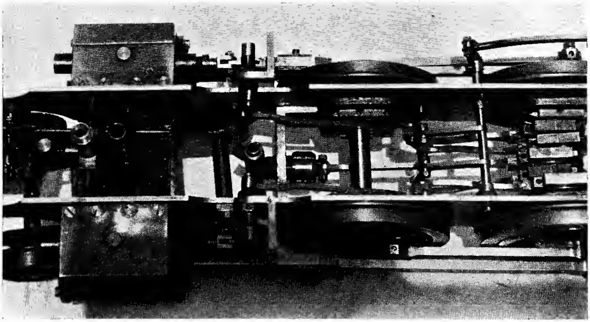
The assembly of the gear can be seen in the photos. Though there is no positive stop to prevent the links coming off the die-blocks, they remain snugly in position; the links cannot move sideways, as their doing so is prevented by the eccentric rods and lifting links, and the links cannot run off the die-blocks at top and bottom, because of the controlled travel of the reversing gear. Owing to the big ports, the eccentrics have a tidy angle of advance, and they also give a lead in full gear. There is nothing "negative" about the products of the "monkey-gland shop"—the only items indicated by that term, came out of Mr. Grose's camera! The usual steam and exhaust connections are fitted, oil from the lubricator being delivered into the path of the steam, via a clack on the steam tee. The lubricator is of the oscillating cylinder pattern, driven from an extended crankpin in the right-hand inside pendulum lever. It ratchets two teeth per stroke in full gear, and one tooth in running position. One filling lasts $1\frac{1}{2}$ miles.

Boiler

The dimensions of this are as per specification, but here again the construction differs. The barrel, instead of being made from tube, was rolled up out of a piece of sheet copper. I have a set of bending rolls, the kindly "bonus" gift of somebody who was pleased with a job I did for him, and these made short work of transforming the bit of sheet metal into a taper tube with $\frac{1}{4}$ in. lap joint. This was riveted in a few places, and the merry old "Alda" oxy-acetylene blowpipe, plus a taste of "Sifbronze," soon made the joint the strongest part of the tube. The joint is at the bottom, and of course, does not show. The firebox wrapper has the well-known G.W. "tumble home" top, but no back slope—which in my humble opinion, spoils the appearance of the G.W. boilers; a late director of the G.W.R. told the C.M.E. in my own workshop, that his boilers looked as though a girder had fallen off a bridge in front of the cab, at which they both enjoyed a hearty laugh. I know, of course, why the big boilers have the back slope; but the result could also be obtained with a parallel top.

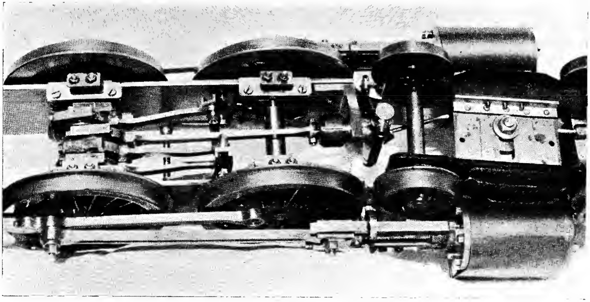
No stepped ring is used to join the barrel to the throatplate. The wrapper, with throatplate attached, was up-ended in the brazing pan, and the squared-off end of the barrel stood on it, care being taken to get correct alignment. Messrs. Alda, Sifbronze & Co. then got busy. A big tip (350 litre) was first used to get the metal well heated up and enable a first application of Sifbronze rod to run clean through the joint, like brazing strip. The tip was then replaced by the usual size (225) and the Sifbronze built up all around the joint. At the top corners of the wrapper, the metal was piled on to represent the shape of the corner lagging plates on the full size engine, which are rounded off nicely; this does not show on the reproduced photo., but you will be able to see it later on in the picture of the finished job, if all goes well.

The firebox and tubes, crown stays, and longitudinal stays are all as specified, but the firebox side and end stays are put in like those on the full-sized engine, no nuts being used. I still have two or three short ends of overhead transmission



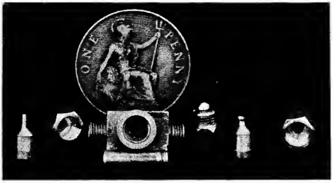
Overhead view of "Purley Grange" "works."

wire, which were originally consigned to Uncle Adolf, but somehow or other managed to take the wrong turning. One of these, about 6 in. long, was unravelled, and the seven copper strands straightened out. The strands are an odd diameter, slightly over that of a 4 BA screw. Each was chucked in three-jaw, skimmed down for $\frac{1}{2}$ in. length to $\frac{1}{8}$ in. diam. and screwed 5 BA; then removed from chuck, screwed right home through firebox and wrapper, and snipped off about 1/16 in. or so from the copper sheet. A specially-shaped dolly was rigged up, to be held horizontally in the bench vice, the head of this being shaped to fit the contour of firebox, with a cup recess for the stay head. The firebox was slipped over the dolly, with the inside projection of the stay in the cup, and a few judicious cracks with a hammer on the outer end of the stay—*not* the copper plate!—formed a head on both ends, and swelled out the stay to a practically steam-and-water-tight fit in the hole. The heads were, however, all sweated over with plumbers' solder afterwards, as a sort of safety-first measure; the copper was heated to the melting point of the solder, and the latter brushed around the stayheads (previously anointed with Baker's fluid) with a small home-made wire brush. This



The "works" from underneath.

sealed up any minute cranny which might have existed. The markings on the side of the firebox, which look like a futuristic artist's impression of the sun setting over the washing on the Siegfried line, are only solder brushmarks, the surface being perfectly smooth. The boiler stood 200 lb. water and 140 lb. steam test with not the slightest leak anywhere.



Parts of a $2\frac{1}{2}$ in. gauge injector.

Variations and Additions

Backhead mountings on a $2\frac{1}{2}$-in. gauge engine cannot be made " to scale " and yet work properly, so we have to compromise. This boiler is furnished with an injector, which is a " standard " fitting on my boilers since I brought the cone sizes " down to a fine art " as they say in the classics, and produced little jiggers that can be used on a $2\frac{1}{2}$-in. gauge engine whilst running. To make room for the steam valve, allow room for the movement of the regulator handle, and still leave room to manipulate each wheel or handle without fouling the others, the blower-valve was shifted to the left side of the backhead, and the injector steam valve installed at the top right-hand side. It can be seen in the picture, but I hope to include a " full-face " view of the backhead in the near future. Another addition is a square-headed washout plug, $\frac{1}{4}$ in. diameter and located just below the firehole door, at foundation-ring level. This is a great advantage in districts where the water is chalky.

The injector, the position of which can be seen in the three-quarter view, has the same sized body as that described for " Miss Ten-to-Eight," but the cones are smaller, the delivery cone being drilled No. 78, and the others in proportion. I made a similar one for Mr. Grose's " Saint " boiler, and our worthy friend pulled his to pieces and took a close-up shot of them, alongside a medallion portrait of the lady who informed Uncle Adolf about his alighting point. The Sellers-type combining cone, and the air release hole can be seen inside the ball chamber. The whole gadget packs nicely away behind the step, on the finished engine. A clack is attached to the leading end, and from the top union of this, a pipe goes upwards, over the top of the trailing wheel, to the feed inlet alongside the safety valve. The eccentric-driven pump delivers into a corresponding position on the other side, the clack on the side of the wrapper being for use with the emergency hand pump only.

On the Road

Since the photos were taken, the engine has progressed far towards completion, and has been several times on the track. The first time out, working with the " Caterpillar's " big bogie tender, she was blowing off at 80 lb. in less than four minutes after lighting up. I usually give them a light run at first, but this one seemed so jolly lively after the preliminary warming-up lap, that I took my seat on the flat car right away, and worked her as though she had been running in service some time. It is absolutely marvellous, not to say uncanny, the way these little Great Western boilers will emulate the efficiency of their big sisters. Properly fired, you can do absolutely anything you like with this one ; start off with low pressure, and climb to blowing off as she runs with a normal load at a good clip, even with the pump working. Either pump or injector can be used whilst running, with equal indifference to the steam generation.

There is not the slightest hesitation nor sluggishness in starting ; she is off the mark with an acceleration reminiscent of *Miss Milly Amp*, as soon as the regulator is opened, with the G.W.-cum-L.B.S.C. deep-toned " bottle-cork " exhaust cracks, dying away to a tiger-cat's purr as she is notched up. After three or four laps everything seemed O.K., so I brought the lever back to " kicking-point," and with the regulator about half open, let her have her own way, upon which she settled down to a steady "scale ninety." My weight is equal to hauling about twenty coaches. She kept going for about $1\frac{1}{2}$ miles, when I let the fire die, as the water in the tender was getting low. There was only one incident : when firing, coming down the southbound straight, I accidently touched the regulator handle with the shovel, and opened it a little wider. The engine leaped forward just as if somebody had given her a push, and I only just managed to save the whole lot " going in the ditch " on the south curve.

There were two incidents on the second run. First, the injector, after working perfectly for about a mile, suddenly packed up. On investigating, I found a tiny speck of coal dust jammed right in the throat of the delivery cone ; removal of this put the jigger as-you-were, but I am fitting a very fine strainer, or " strum " as the enginemen call it, to the engine's own tender, so that this will not occur again. Towards the end of the run, she went " off beat " when notched up to running position, and this proved to be the result of one of the suspension lever fulcrum pins coming loose, which was promptly remedied and " insured against." Since the above, everything has gone fine, no trouble whatever. I am quite satisfied with the results obtained with the open box links in the valve gear, and confidently recommend this type of link to anybody who has trouble in filing or otherwise cutting the slots in the ordinary type of closed link.

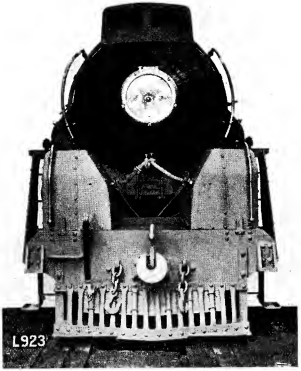
Railway Practice

By Chas. S. Lake, M.I.Mech.E., M.I.Loco.E.

British-Built Locomotives for New Zealand

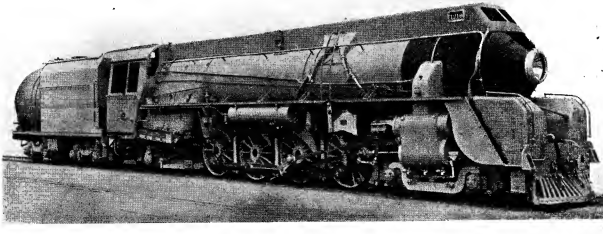
BRIEF reference was made in a recent issue under the above heading to the fact that a number of locomotives had recently been shipped from this country to New Zealand. The engines, 40 in number, are of the 4-8-2 type, and are to be known as the " J " class; they have been built by the North British Locomotive Co. Ltd., Glasgow, and are for working mixed traffic on the 3 ft. 6 in. gauge Government Railway system laid with 50 lb. rails.

One of their number is, by courtesy of the builders, illustrated herewith, and it will be seen that a modified form of streamlining has been adopted. The equipment throughout is of a very modern description, all the wheels of the engine and tender being fitted with roller-bearing axle-boxes, whilst the valve motion pins have needle roller bearings, and roller bearings are also used for the return cranks. The boiler is equipped with a 16-element superheater combined with which is a steam dryer, and the regulator is located in the superheater header in the smokebox. The firedoor is operated either by compressed air or hand, spark arrestors are used, and the reversing gear is also actuated by means of compressed air. The valve motion is on the American Baker system, and electric-lighting fittings are included.

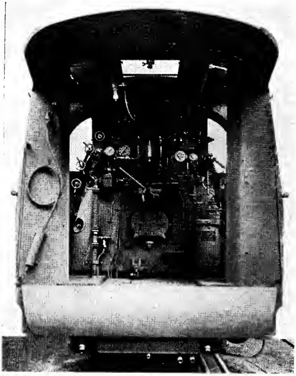


Front end of 4-8-2 type New Zealand engine.

The leading dimensions are: cylinders (2), 18 in. by 26 in.; coupled wheels, diameter 4 ft. 6 in.; engine bogie wheels, diameter 2 ft. 6½ in.; hind truck wheels, diameter 2 ft. 9 in.; coupled wheelbase, 14 ft. 3 in.; total engine wheelbase, 33 ft. 1½ in. The boiler heating surfaces are: firebox, 149.5 sq. ft.; tubes, 1,319.5 sq. ft.; total, evaporative 1,479.0 sq. ft.; superheater 283.0 sq. ft.; combined total, 1,752.0 sq. ft.; grate area, 39 sq. ft.; boiler pressure, 200 lb. per sq. in.



New " light " 4-8-2 type express locomotive, New Zealand Government Railways.



Interior of cab, New Zealand locomotive.

The tender has the Vanderbilt type of cylindrical water-tank, the capacity of which is 4,000 gallons, and six tons of coal are carried. The wheels of the tender are 2 ft. 6½ in. diameter and the wheelbase is 15 ft. 10½ in., that of engine and tender combined being 58 ft. 0 in.

In working order the engine weighs 63 tons 13 cwt., and the tender 40 tons 7 cwts. The tractive force at 85 per cent. b.p. is 26,520 lb. The locomotives come within the category of "light" pattern with a maximum axle loading of 11 tons 10 cwt.

G.W.R. High-Capacity Open Wagons

The Great Western Railway has in use a number of 20-ton open freight wagons of the type illustrated herewith, and to satisfy the requirements of a Swansea reader who desires to build a vehicle of this class on model lines the writer applied to Mr. C. B. Collett, the company's chief mechanical engineer, who has kindly provided a photograph and dimensions of the type.

The wagons are built for the heavy iron traffic passing between steel and iron plate works in the Swansea district; each of the vehicles has a carrying capacity of 20 tons, but with the same length of body and wheelbase as the standard G.W.R. 12-ton wagon in order to meet all requirements with regard to sidings, turn-tables, loading banks, gantries, curves, etc., at the various works.

They have wooden bodies and steel underframes, and, to protect the inside of the body at the ends, plates 1 ft. 6 in. deep and ½ in. thick have been fitted into the end sheeting for the full width of the wagon. The carrying capacity as indicated is 20 tons, wheelbase 9 ft. 0 in., length over body 16 ft. 6 in., width over body 8 ft. 0 in., and depth of body inside 2 ft. 11 in.

L.M.S. 2-6-0 Type Engines

In reply to the correspondent who asked for the publication of a drawing and photograph with dimensions of the Stanier 2-6-0 type locomotive, L.M.S.R., the writer referred the matter to the Editor, who has agreed that these shall be included in a future issue in the "Railway Practice" columns, Mr. Stanier having kindly provided the necessary material for the purpose.

High-capacity open goods wagon, Great Western Railway.

Model Engineers and National Service

Multi-tool lathes

By Edgar T. Westbury

NOT many years ago, the universal tendency in the design of production lathes was drifting steadily away from the old principle of turning work between centres, in favour of lathes in which the work was either entirely or mainly supported in the chuck. The latter category, of course, includes all capstan and turret lathes, and these were so overwhelmingly superior in respect of production rate, as compared to centre lathes, that many experienced production engineers predicted that the days of the latter (in quantity production work, at least) were numbered, and that it was doomed to eventually become obsolete.

The centre-lathe, however, has always been found necessary to deal with certain components which were inherently unsuited to production in chucking lathes, and, in spite of its comparative slowness in turning out work, no factory could afford entirely to dispense with it. Of recent years, however, revolutionary changes in the design of this type of lathe have put it on a basis of equality, in respect of production rate, with the most advanced types of chucking lathe; in fact, it shows a great superiority for many classes of work. This improvement is due to the introduction of lathes in which the salient feature is the simultaneous use of several cutting tools—in other words, "multi-tool" lathes.

The idea of using several tools at once is not in itself a new one; in fact, it is very old, and even before the beginning of this century, lathes were made having more than one tool-post, and in more than one case slide-rests, saddles and other important components have been duplicated. In the locomotive industry, for instance, special lathes have long been employed for turning two wheels, mounted on their axle, simultaneously; these have two opposed power-driven headstocks, with live centres, and two saddles, with slide-rests, by means of which both wheel-treads can be machined. It would be quite possible, and logical, to introduce a third sliding saddle by means of which the centre portion of the axle could be machined at the same time; but this is usually unnecessary, as the axle is fully machined previous to mounting the wheels, and serves only as a mandrel in the particular operation in question.

Ordnance lathes, for turning the barrels of large guns, also have two sliding saddles, in order to shorten the length of traverse necessary, and thus reduce the time taken in this operation. This principle is, as we have seen, often utilised in capstan and turret lathes too; but in this case no alteration in the design of the lathe itself is involved, the necessary provision being made in the tool-holder equipment.

Some of the early attempts at multi-tooling were really in advance of their time, and failed to secure the advantages which were logically expected, or were incapable of being developed to really useful capacity, because of the limitations of the machines to which they were applied, or the deficiencies of the tool steels then employed. It took a good many years to drive home the realisation that, for multi-tooling to be really successful, a completely new and specialised type of lathe, adapted particularly for the extremely heavy duty involved, would be necessary. And in the meanwhile, machine-tool designers were so busy developing capstan and turret lathes that very little attention

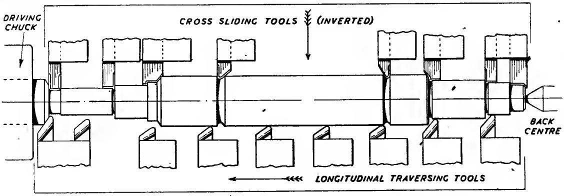


Fig. 1. Method of machining a dynamo shaft on the "Maxicut" lathe.

was paid to the possibility of keeping the centre-lathe as fully up-to-date.

Messrs. Drummond Bros. Ltd., of Guildford, whose name needs no introduction to model engineers, were pioneers in the development of the modern multi-tool lathe, and their " Maxicut " series of lathes has been responsible for many revolutionary changes in production policy in a wide variety of industries, including automobile, aircraft, armaments and electrical machinery manufacture. In many cases where the nature of the work has demanded the use of a centre-lathe, the " Maxicut " lathe has enabled output to be speeded up to an extent never before contemplated. It has been stated by production experts that the application of this lathe in automobile manufacture has helped very materially in reducing the cost of the modern car.

Apart from the simultaneous use of a number of simple or compound tool-blocks on the main traversing slide of the lathe, which is common to all the machines in this class, the " Maxicut " lathe incorporates another very important principle namely, the use of a second slide at the back of the bed, carrying another set of tools which are fed and controlled independently from, but simultaneously with, those of the front slide. The principle can be still further extended by the use of additional slides, but, in the majority of cases, all machining needs can be met by a lathe having a front slide carrying all tools which have a longitudinal traversing movement, and a rear slide carrying all the tools which have a radial movement.

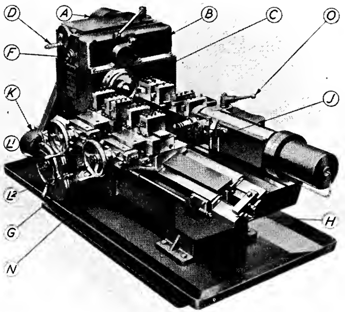


Fig. 2. The No. 1 " Maxicut " lathe.

By courtesy of Messrs. Drummond Bros., I am enabled to give a completely detailed description of this very interesting series of lathes, together with some typical examples of work carried out on them and methods of tool arrangement.

The " Maxicut " lathe may be described, basically, as a machine somewhat of the centre-lathe type—i.e., having a rigid headstock and adjustable tailstock mounted on a bed—but the saddle and cross-slide are replaced by units designed to take a multiplicity of cutting tools. The saddle will support up to three or four cross-slides, each carrying several tools, and feeding in a longitudinal direction automatically. The rear slides, which may be up to four in number, are also operated automatically, independent of the front slides, and feed in a crosswise direction only. The feature of the multi-tool lathe is that when the workpiece has been set in motion, the front slides fed into their forward stops, and the automatic feeds engaged, all the tools commence to carry out their respective duties simultaneously—i.e., the tools on the front slides turn the diameters, of which there may be several, whilst the rear tools turn all the faces, shoulders, undercuts, tapers, etc. Thus in the case of a dynamo shaft, for instance (Fig. 1), the whole shaft is turned in one operation and the time taken is only that required by the longest single cut. It will be seen, therefore, that as compared with the time required to carry out the operation of each tool separately, one after the other, the time saved by adopting multiple tooling is very substantial indeed. Whilst the simplicity of the above is typical of the majority of workpieces, many are not so straightforward, and the equipment frequently has to include taper turning, form turning and other devices which will be described later. The tooling is, nevertheless, generally of a simple form, comprising independent tool-blocks mounted on the front and rear tool-slides, and each carrying one or more standard single-point cutting tools. This renders the application of multi-tooling inexpensive, quick to set up or change over from one piece to another, and thus applicable economically to comparatively small batches of workpieces, as well as on long runs, such as encountered in the automobile and aircraft industries.

Due to the fact that a multi-tool lathe is set up to operate on one piece for the run, the headstock is not provided with a wide range of selective speeds. It is customary to provide one speed only, which may be varied by selecting the necessary pick-off gears when setting up the machine. These

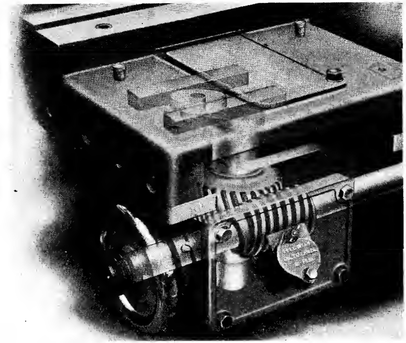


Fig. 3. Rear end of cross-slide, showing worm gear driving vertical shaft, which operates the slide by means of a crank at the upper end.

are assembled, one on the pulley shaft and the other on the intermediary shaft, and their ratio determines the speed of the main spindle. The pulley shaft is also provided with a double multi - plate clutch, operated by a single lever which may be moved to one of three positions-- namely: driving, neutral and braking. The object of the last - mentioned position is to save the time normally required for the spindle to stop revolving after disengaging the drive, which time would otherwise amount to many hours on a long run.

It is customary to provide both a centre taper and a flange on the spindle nose, for whilst a few workpieces may be mounted between centres, the majority require some form of holding device, which is bolted to the face of the flange and accurately located on a recess in same. Another form of quick clamping device for plain shafts is the " Maxigrip " driver; in this instance the piece is mounted between centres, and as soon as the spindle is set in motion two cams automatically grip and drive the piece. Still another form of drive used extensively is the internal expanding mandrel for holding pieces having (usually) a rough machined bore, such as aero engine cylinder barrels, cylinder heads, shell barrels, automobile rear-axle tubes, etc. The expanding mandrel is operated by an air cylinder, mounted on the back end of the main spindle, which operates a draw-bar passing through the latter.

The tailstock is of the revolving quill type, mounted in heavy roller bearings, and fed forwards either by handwheel or air-chuck. For initial setting, the body is movable along the bed-ways, so as to accommodate workpieces of various lengths within the capacity of the machine.

One outstanding characteristic which is to be noticed in the multi-tool lathe is its exceptional rigidity, for it will be appreciated that when there are a multiplicity of cutting tools all operating at once the strains on the headstock, tailstock bed-ways, etc., are increased in proportion; massive construction, therefore, becomes an essential feature for production to the high standards required.

Fig. 2 shows a semi - plan view of the No. 1 Drummond "Maxicut" multi-tool lathe, having a capacity of 9 in. by 30 in. This machine is one of the most popular of all multi-tool lathes, and large batteries are to be seen operating on a wide range of components in most of the automobile and aircraft factories in Great Britain. The motor (not shown) is mounted on top of the headstock, and drives down by texrope to the main pulley A. The power is then transmitted through a multi-plate clutch and the pick-off speed-change gears (which are located behind cover B), massive spur gears, to the spindle C. The lever D operates a pair of sliding gears to give two alternative spindle speeds without changing the pick-off gears; altogether a total of eight speeds are obtainable, and all shafts are mounted on ball or roller bearings. To meet the heavy duties these machines are constantly performing, the nose end of the spindle is mounted in oversize duplex taper roller bearings. The multi-plate driving and braking clutches are operated by the lever E. F is the oil gauge to the oil bath for the headstock gears on the final drive; other gears and bearings are lubricated by a pump located under cover B.

A characteristic of the "Maxicut" range of machines is the inclined bed and saddle ways seen at H and J respectively; these offer greater resistance to the strains set up by the cutting tools, and also to assist in keeping the surfaces clear of cuttings. The feed motion is transmitted from the main spindle to the pick-off gear box K and through a spring-loaded safety clutch to the final pick-off gear box G, where the front and rear feeds can be varied independently. The power feed is engaged by moving a lever on the top of the box G; this feeds the saddle towards the headstock, through rack and pinion, and also drives a cross shaft, which in turn provides a cross feed to the rear slides. In the machine illustrated, two front and rear slides are fitted, carrying in this instance twelve cutting tools. The front tools are fed into the work by the handwheels L1 and L2, their forward position being located by the adjustable stops N.

The rear slides on the No. 1 " Maxicut " lathe are a departure from the usual practice, and incorporate a unique feed system which ensures an exceptionally high standard of accuracy. The method of operation is as follows: the cross-shaft referred to earlier, which is driven through change gears, drives the back shaft, Fig 3, through bevel gears running in an oil bath.

The shaft passes through an oil bath gear box under each rear slide unit, where a worm and worm wheel drive a vertical shaft, having a crank at the upper end. This crank engages with two hardened strips in the base slide, and gives a feed of 4 in. from the rear to the forward dead centres; it also provides a slowing down of the rate of feed as the crank reaches the dead centre—a desirable feature, especially when taking deep or heavy cuts. Although a mechanical screw-stop is provided to determine the end of feed, it is not on this that the accuracy of the cut depends, but on the forward dead centre of the crank. To accommodate various sizes of workpiece, the top slide is adjustable on the base slide, and the whole rear-slide unit is adjustable along the rear shear of the machine bed. Both front and rear slides can be supplied in various widths, to suit the workpiece or range of workpieces for which the machine is required.

The tailstock illustrated is air operated; it consists of a massive body, mounted on the rear shear of the bed, and housing a sliding barrel, which in turn carries the revolving centre in heavy taper roller bearings spaced well apart. To obtain the utmost rigidity, and so as not to rely entirely on the air pressure, the hand lever O is used to clamp the barrel as soon as the workpiece is located between the centres.

(To be continued)

Hints and Gadgets

Short original and practical contributions to this page are invited from readers, and will be paid for. Write on one side of the paper only; address items to the Editor of THE MODEL ENGINEER, *and mark envelopes " Workshop Hints."*

Cleaning Files

EVERY model engineer at some time or other has encountered difficulties due to clogging of file teeth when filing comparatively soft metals such as aluminium, brass, bronze, copper, etc. Often a file is discarded as worn out when really all it needs is proper cleaning.

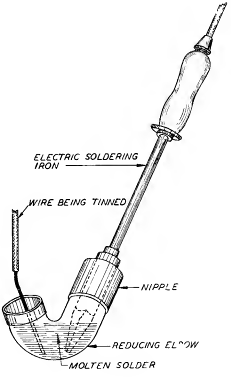
One effective method of file cleaning is to use a piece of flat mild-steel with a fairly sharp edge and push across the file in the direction of the cut, using slight pressure. A few movements across the file in this way will eliminate the chips or particles of metal that have clogged.

When aluminium or aluminium alloys are the metals to be removed from file teeth, immerse the files in a strong caustic soda solution for a few seconds, after which the metal particles can easily be brushed off with a steel wire brush or file card. To prevent rusting after this treatment, wash in clean water and dry in warm sawdust, or wipe the files with an oily rag.

Another method consists of immersing the clogged file in concentrated nitric acid for a few seconds, withdrawing it, washing in running water, and drying in hot sawdust. It must be remembered, however, that nitric acid has a violent action on the skin, which possibility must be avoided.—A.J.T.E.

Tinning Small Parts

AN electrically heated tinning bath for small parts can be made up from a gas-reducing elbow,



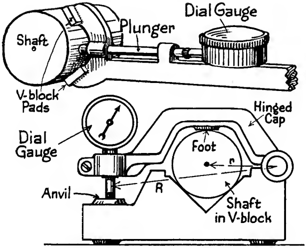
screwed into a short 1 in. gas nipple, into which an electric soldering iron is pushed. This keeps the solder in melted condition.—F.C.

* Gauges and Gauging

A series of great value to engineers of all classes, particularly those who are engaged upon national service

By R. Barnard Way

IN our last article we showed some applications of dial gauges used to indicate very small errors in manufacture, finishing up with a test of internal truth of a cylinder. Here are some further uses for these gauges, in a direction in which they can be invaluable to the general engineer who has to maintain a good standard of accuracy. Some weeks ago an article appeared in THE MODEL ENGINEER in which it was demonstrated that a shaft that was checked as truly round by micrometer need not be so. It was, in fact, of a rounded equilateral triangular shape. Some years ago, when testing roller gauges for the Hoffmann Company, the National Physical Laboratory made this discovery, finding a considerable variety of shapes. All of them were symmetrical, and the number of the lobes varied from three to nine. Whilst this character did not affect their value for the purpose for which they were designed, it occasioned a good deal of surprise at the time, because it had been believed that the methods used in their manufacture should have produced perfectly circular sections.

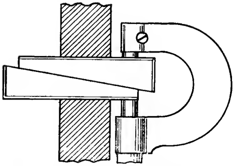


Two shaft gauging appliances using dial gauges.

A simple test with a dial gauge would quickly demonstrate the inaccuracy of such a section, however small the variation. Here are shown two arrangements for gauging shafts for roundness, one of which can be employed on a shaft running in its bearings, though the top cap has to be removed. This latter can be invaluable to the repair shop man, as it will give him information about a crankshaft that he may suspect of wear, without the necessity of stripping down the whole engine. The device is simple enough in construction and use, consisting in effect of a V-block in the form of two arms at the end of a handled rod. Each of these arms has a hardened, ground and lapped surface, the two surfaces making an included angle of 60 degrees. A push-rod passes through a hole drilled in one of the arms, and one end of this would bear on the shaft under test, the other against the foot of the dial gauge. Before using this gauge, it should be set to a master gauge of the diameter required, if this is possible.

The other shaft-gauging appliance can be understood well enough by reference to the sketch, where it is shown in end view. The shaft is rotated in what is actually a V-block, and on it bears a heavy hinged cap with a hardened steel foot inside it to make contact with the shaft surface. On an extension of this cap is a clamp carrying the dial gauge, the foot of which bears on an anvil formed on the lower half of the whole assembly. The action is clear enough, but, of course, the indications given by the dial gauge will be in proportion of the radius R to radius r.

The next subject that calls for attention is the precise measurement of round holes, both as to their diameter and also their depth, where they are recessed holes, and not passing right through the work. It is larger holes to which we refer, of course, not those that can be gauged by means of plug gauges.



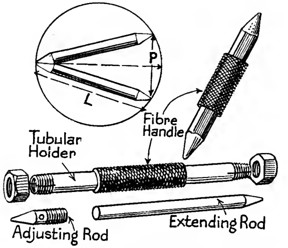
The wedge method extends the hole so that an *outside* measurement can be made.

Using a pair of inside calipers and a micrometer gauge, the expert hand *can* get measurements of an internal diameter with precision to 0.0001 in.; but there are difficulties about it. Try it yourself and see how many times you can get the same

* *Continued from page* 324, "*M.E.*," *March* 28, 1940.

result in six trials. You may be surprised. The first difficulty is to get the same " feel " with the caliper points and jaws of the micrometer. It is not easy, and, where an exact figure is wanted, neither the first nor the second readings should be accepted, unless they agree.

A very useful outfit is the set of wedges put up by most gauge-makers. These can be inserted into the hole and adjusted until they are a close fit.



Pin gauging method, and an adjustable gauge of this type that the mechanic can make.

An extension of the hole diameter can thus be produced, enabling an ordinary micrometer measurement to be made as shown. The wedges are made in a variety of sizes, for measuring holes from $\frac{1}{4}$ in. to 1 in. in diameter; the slope to which all are formed is a taper of 1 in 5. Their accuracy can be checked easily by insertion into ring gauges.

Once more we must remind the reader that holes that have to be gauged have also got to be clean, without suggestion of oil film in them. Oil will even make it possible to pass a plug gauge through the hole that would normally be reckoned as too tight a fit, so see that the hole is dry. A hole that is burred or bell-mouthed also provides trouble, and no very accurate measurement of it can be expected.

Perhaps the best type of gauge for medium-size holes is the pin gauge, which is simply a steel rod with conical ends, the points being nicely rounded and finished to gauge size on a fine oil stone. If it is wanted for very accurate gauging, it is as well to cover the middle portion with a short length of fibre tube, so as to insulate it from the heat of the hand, which would possibly be sufficient—under workshop conditions—to make it into a " not-go " gauge. It should be made a nice fit in the hole, with no side-to-side slack whatever. A pair can be made " go " and " not-go " lengths, but it is possible to estimate the excess diameter from the side-to-side play; in fact, if you can measure this exactly, you can say by means of the formula herewith what the diameter is to the nearest thousandth.

The diagram here shows the details, and from the formula $L + \frac{P^2}{8L}$ you can calculate the actual diameter. Suppose the length of the pin-gauge is 6 in. and the side play is 0.300 in., then the true diameter is 6.002 in. This sounds remarkably accurate, but it is quite in order to measure a hole that way, so long as you are very sure of the length of your pin-gauge.

A good adjustable pin-gauge can be made out of a length of $\frac{3}{8}$ in. steel tube, screwed taper and split for $\frac{1}{2}$ in. at each end, with nuts to screw on and tighten up. At one end the tube is screwed internally to take a short screwed steel rod, hardened and ground to a good slightly rounded point. A hole should be drilled to take a slender tommy-bar so as to permit nice adjustment as to length. In the other end a length of rod slides right in to the full length of the tube; its outer end is also hardened and finished like the first rod. Approximate adjustments of length are made with this sliding rod, and final adjustments by means of the screwed rod. This is a useful tool and worth the slight trouble entailed in its making.

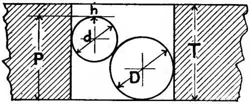
An unusual method of getting at the diameter of a hole is the steel-ball scheme, but it can hardly be recommended for workshop practice, as it involves a calculation by means of a somewhat intricate formula not easily remembered. The thickness of the metal through which the hole is bored must be exactly known, and the diameter of two steel balls of differing sizes that will drop into the hole and rest below the surface in such a way that they do not both touch the bottom. The sketch will show the idea. You have now to measure the depth from the surface to the top of the upper ball, and from this point the distance perpendicularly to the bottom of the hole can be got out by subtraction; we call this P, the thickness of the metal T, and the diameters of the balls D and d. The required diameter of the hole is given by the formula

$$\frac{D+d}{2} + \sqrt{P(D+d) - P^2}$$

Let us take an example, using balls of $\frac{7}{8}''$ and $\frac{5}{8}''$ diameter (0.875″ and 0.625″). These drop into a hole of depth $1\frac{5}{16}''$ (1.3125″) so that the smaller one rests $\frac{3}{16}''$ (0.1875″) from the surface. Thus we have D = 0.875, d = 0.625, and P = 1.125″.

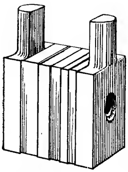
Diameter of hole =

$$\frac{0.875+0.625}{2} + \sqrt{1.125\,(0.875+0.625) - (1.125)^2}$$
$$= 0.75 + \sqrt{1.6875 - 1.2656}$$
$$= 1.399''.$$



The steel ball method.

For this formula, as also the previous simple one for use with the pin gauge, we are indebted to Mr. F. H. Rolt's comprehensive work on gauges and fine measurement.



Calipering end blocks are a useful addition to the block gauge set.

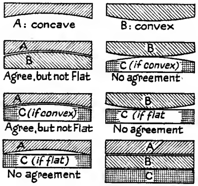
This sort of measurement is rather too suggestive of the National Physical Laboratory to be practical in even the best-conducted tool-room, so we will go on to more practical considerations. The makers of block gauges generally supply calipering end-blocks for assembly into gauges for internal measurements, as illustrated here. The measuring ends are marked as to their thickness; usually three sizes are available—0.1 in., 0.2 in. and 0.25 in.—and they can be wrung to an assembly of gauge blocks so as to give increases by 0.0001 in. until the hole is correctly gauged.

An alternative method is to use a pair of accurate rollers with a group of block gauges in between. Gauging rollers are guaranteed accurate to + and — 0.0001in., but as a rule they are made in fractional diameters, from 3/16 in. to 1 in. This can be an accurate method of determining an internal dimension, as the rollers give point contact with the sides of the hole, but it is limited, of course, by the limits of the gauge blocks. Normally a limit of 0.0001 in. is as far as most workshop processes ever need to go, and, as we have pointed out before, it is not often that insistence on such a degree of accuracy is really justified.

For large holes a considerable range of micrometer gauges is available, where measurements are required. These need no further mention here. Where the stricter process of gauging is in hand—that is, a comparison with a standard—fitments similar to that shown for use with a dial gauge can be used. The Hirth minimeter can be used thus, with a frame having two ball feet. Set first to a standard gauge, it will then register the difference clearly. Various forms of star gauges can be had; these have three arms, one of which is adjustable. The establishment of true circularity in a large bore can generally be done with a device of this sort, turning it to at least six different positions, in every one of which the indications should agree within whatever limit has been imposed.

So much, then, for the time being, about gauging holes. There is another most necessary feature of machine work that we have already touched upon a little, and that is flatness, to which may be added straightness. Are there any tests for these? In the ordinary way of it there are not, excepting the comparison with other surfaces and edges believed to be flat and straight—which is, of course, no more again than reference to the standard, whether of length, surface, volume or weight. We must have these standard pieces available, and they must be maintained in good order if serious work is to be done.

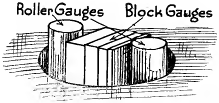
The chief reference as to flatness in the shop is the surface plate; for straightness the heavy straight edge of the cast-iron variety, as well as the steel edge. In the tool-room they will have, in addition, the toolmakers' flat, a steel disc that we have already seen; probably an optical flat also, a glass disc which has been ground to a degree of flatness accurate to about 0.000002 in. The straight edges will be of the short, handled, knife-edge variety.



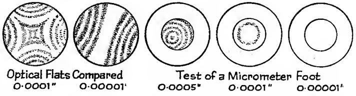
This illustrates the principle of the three agreeing surface blocks.

Light is the chief ally of the careful workman who wants to finish a surface flat and straight. Chinks of light no more than 0.0001 in. wide show plainly as white; less than this appears as a colour—clearly one of the prismatic colours, indicating that the gap is of less width than a full wavelength of white light.

(*Continued on page* 377)



Roller gauges and block gauges combined to measure the hole diameter.



Gauging by means of optical flats, observing the form of the interference fringes. No appearance at all indicates perfection to within ten one-millionths of an inch.

Simple Tool-holders

By F. Hall Bramley

MOST turners like to have tools forged out of the solid square or oblong section bar cast steel, and many have their own particular fancies as to the shape of these. To the writer the great advantage of the solid forged turning tool is that the mass of metal carries away the heat better than do the small cutters used in the tool holder.

But the tool holder has the very great advantage that it enables one to use small-sized cast steel for the tools and so save expense, and it does away with heavy forging. The cutters for lathe tool holders can be filed to shape easily and hardened and tempered without a forge or powerful blowpipe. Even a Bunsen burner will be found powerful enough.

There are elaborate tool-holders on the market which can be had in various shapes and sizes, but a set of holders can easily be made which, with small stock cast steel, will cover all the purposes of general metal turning for small mechanical work. In most cases the tool holders are made from square or oblong section mild steel and to take cutters made from $\frac{1}{4}$ in. round cast steel.

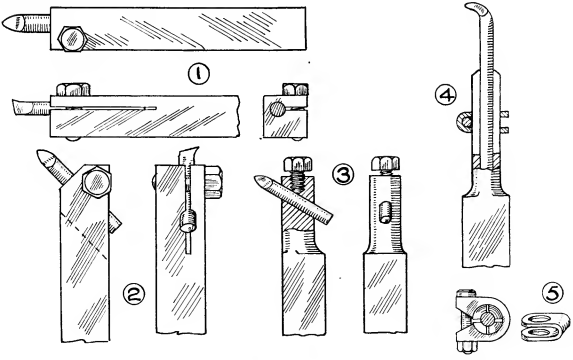
Where heavier work is to be done, it is evident that the size of the cutter-holding bar and the cutter itself can be increased. But the holder bar will best be made of a size to suit the tool box or tool holder of the lathe compound slide rest—whatever size it is designed for—since rigidity is the most valuable feature in all turning operations.

In Fig. 1, a square mild steel bar is bored down from one end near a corner of the square section (as seen in the end view) to take the $\frac{1}{4}$ in. cutter. It is slotted by a saw cut at the side and a hexagon or square-headed screw is fitted, clearance in one half and threaded in the other, to draw the holder tightly around the cutter. The slot, which only reaches to the hole, should be made with a circular saw or cutter. Failing that, it should be sawn, as far as it can be diagonally, with a hacksaw, and drifted from that with a steel drift chisel. It is not advisable that the slot should go across the $\frac{1}{4}$ in. hole which takes the cutter—only into one side of it.

The screw should be case-hardened if a mild steel screw of standard Whitworth thread is used, but it is best to make a special cast steel screw with a square head to fit a square box-spanner and to harden and temper it.

In Fig. 2 is shown a similar tool, but with the cutter at an angle. This can be used right or left hand, or, with the cutter slanting upwards instead of sideways, it makes a good tool for sliding long shafts or facing across the faceplate for surfacing. It is made in the same way as the tool shown in Fig. 1, but no difficulty arises as to sawing the slot, which in this case is sawn right across the stock and at an angle at the bottom, as indicated by the dotted line.

In Fig. 3 is a boring tool for inside work where



Simple tool-holders.

there is clearance at the end of the cylinder. The square stock is turned at the end to a diameter just under its flat width. A hole is bored at an angle—about the angle shown—and a ¼ in. hardened Whitworth square-headed setscrew is fitted in a tapped hole axial with the turned end of the stock of the tool. This setscrew should be hardened and tempered and have an end with a taper corresponding to an angle which the cutter makes with the axial line of the holder. It then has a good hold on the cutter.

In Fig. 4 is shown a very handy tool for boring—cleaning up a hole which has first been drilled by a twist drill fed up by the barrel of the back headstock. This tool should be made of square cast steel bar—not mild steel. It is chucked in the four-jaw chuck and the ¼-in. hole is drilled up it centrally. Then the back centre is fed up to hold the tool by centring in the end of the hole, and the end of the tool is turned along parallel and giving about 3/16 in. wall all round the quarter hole. It is then slotted across by two slots at right-angles (as shown in the end view). These slots should be cut with a very thin and very fine toothed hacksaw blade, and should extend to the length shown approximately.

The cutter can be forged or bent and filed to any suitable shape. It should have as full length as possible in the hole. It is held tight by the clamp shown.This is made by bending, round a ¼ in. rod, a piece of ⅛ in. flat steel plate. A piece of wood or other packing is then placed between the two sides, and it is drilled, as shown in Fig. 5, through both laps with a drill of the same size as the parallel turned end of the tool holder. It is then slotted across as shown in the top view (Fig. 5), and the free ends rounded to conform with the circle of the tool holder.

A 3/16 or ¼ in. bolt and nut placed through the folded end will then draw the clip around the split end of the tool holder and hold the tool with the greatest tenacity and rigidity.

This clip can be fitted anywhere along the slotted part of the holder to clear work being operated on, and it can be turned round as desired. It will, of course, be placed as near the end of the holder as is possible according to the nature of the work, so that the tool is clamped as near its working end as possible to ensure rigidity and prevent chatter and spring.

Gauges and Gauging

(*Continued from page* 375)

The wavelengths of the three primary colours of light are approximately as follows:

Red .... 0.00003 in.
Yellow .... 0.000023 in.
Blue .... 0.000018 in.

If the visible gap seen between the work and the true edge shows in every one of these colours, some indication of its width can be estimated from the figures given. Green is midway between blue and yellow, and orange between yellow and red. Curiously, if the gap is less than about 0.00001 in. it shows as quite clearly black.

When judging work by this method it is necessary to employ a very strong light, and daylight is the best of all, apart from being the cheapest.

Surface plates, toolmakers' and optical flats are always made in threes, each one of which is faced up with each of the other two in accordance with the principle laid down by the great Whitworth. It is impossible for three surfaces to agree perfectly unless all three are exact planes. Two can agree without being flat, for they can be correspondingly concave and convex, as at A and B. There is no contour possible for surface C that will agree with both A and B; if convex it will agree with A but not with B, if concave it will agree with B but not A. If it is flat it will agree with neither.

When working on the surfaces of plates, it is usual to find the high spots with a colour such as prussian blue; but this is not absolutely necessary, for, if the surfaces are well cleaned with petrol and then allowed to dry, they can be viewed obliquely from a distance of eight or ten feet with daylight shining strongly across. The high spots then show up brightly by comparison with the surrounding surface, which is dull. These spots are scraped down, but the final surfacing must be done by abrasion.

If two small pieces of plate glass are placed in contact, an irregular system of prismatic colour-bands will be observed. The nearer the surfaces are to exactness the more regular will be the pattern form of these bands, and if coloured light is used to view them their appearance is accentuated. Here are some sketches to show possible forms of these patterns. Only 0.0001 in. of gap between the surfaces will show as a regular pattern, and a tenth part of this appears in the form of bands running across in the form of slightly curved lines.

A glass-proof plane can be used quite well with steel when a highly flat surface is required on any tool surface, such as the anvil of a micrometer, or even the base of a surface gauge.

Optical flats can be made with an error of no more than 0.000001 in. between them, but these are not workshop appliances. A good straight edge set will be provided with a glass-proof plane for checking purposes; but this must not be used for any other testing work, for, though glass will stand up to a good deal of wear, it is not difficult to scratch it with hardened steel.

(*To be continued*)

The Search for Perpetual Motion

By Waring S. Sholl, A.M.I.E.E.

EVER since the first adoption of mechanical power on a practical scale, there has been a search for the impossible, in the form of " perpetual motion," so-called. This term is, like those attached to other visionary propositions, such as the " Elixir of Life " and the " Philosopher's stone," overdrawn possibly to form a catchword and a bait for the unwary investor. The term " perpetual motion " obviously overstated its own claims, as no device could possibly go on working indefinitely and thus defy eventual destruction due to wear and tear.

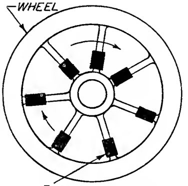


Fig. 1. Falling weight system.

Cutting the claims down to the minimum, the least practical mind sought a means of creating power in a machine which, while subject to the limitations of wear, would not only drive itself but would provide " power to spare." The searchers after this " new source of power " found a fresh inspiration in the introduction of steam and its profound influence on both manufacturing and transportation.

Coming to the methods adopted, these undoubtedly did contribute results of some value in providing mechanism in which friction was appreciably reduced and technique advanced. And so out of the quest for " perpetual motion " came mechanical truths, as from the fallacies of astrology and alchemy arose the truths of astronomy and chemistry. The machines, which varied greatly in design, all aimed at producing a continuity of power after receiving the initial impulse. As the modern idea has it, the machines were, very decidedly, " hand starters." They all aimed at " building up power " as the machine got " warmed up," and it is, in view of the enthusiasm and faith of the inventors, surprising that " governors " or even brakes were not invented to prevent the machines from running away on no load!

Not content with the obvious fact that a simple wheel would come to rest soon after being set spinning by hand, attempts were made to " build up power " by a positive reaction which applied the necessary impetus at the critical moment. Hence were introduced the " falling weight " systems as the simplest additions to the plain wheel. The sketch, Fig. 1, gives an idea of an early attempt. Here the inventor claims to have got ahead of physical laws in artfully having an odd number of spokes to his wheel. The spokes carried sliding weights which were claimed to borrow power from the " increased leverage plus centrifugal force " obtained when the weights shot out from the centre to the circumference. The weights certainly did " borrow power "—which had to be repaid with interest—on the next half revolution. The illustration shows *four* weights ready to oblige the remaining *three*, which thus, in every sense of the word, " put one over " physical law.

This idea being again unsuccessful, did not deter the inventor. Instead of resting content with the simpler apparatus, and its plain lesson, the next attempt included toggle levers, which claimed to " restore the weights " from the circumference to the centre, and so get round those trifles known as gravity and friction. Weights being cumbrous and heavy, springs, very possibly borrowed from the then progress in watchmaking and horology generally, were adopted by another " school " of this elusive art.

From this, strangely enough, came not a more complicated but a simpler piece of mechanism. The drawing, Fig. 2, taken from an illustration over 102 years old, gives an idea of the adop-

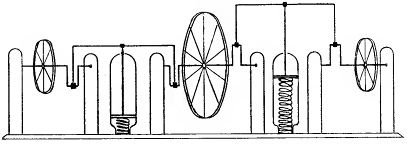


Fig. 2. Spring reaction type.

tion of springs, assisted by cranks. The "source of power," viz., the helical springs, are concealed in cylinders obviously to impart a "steam flavour" highly popular in those days of "steam" bakeries, printing works and "steam factories" generally. The inventor's own words are: "indeed it would work two machines at once by adding the second wheel"—seen on the left.

Now came the turn of hydraulics, and after being beaten by the "self-sustaining syphon," Fig. 3, these inventors followed the majority of their predecessors by adding complications according to the old fallacy of providing more "power raisers." Here the builder of new machines—and hopes—borrowed a leaf from the millwright's book and had a go at the water wheel. An illustration, not reproduced, shows a water wheel in a still pond —and not in the mill race—busily driving an Archimedean pump which obliged in turn by supplying the over-shot wheel with its quota of water. A section of the mill shows the millstones

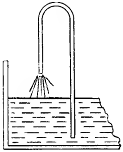


Fig. 3. Self-sustaining syphon.

driven by the "surplus power" provided in such surprising fashion at no cost. The plan, in fact, makes the "power cycle" complete. This arrangement is reminiscent of the model at South Kensington, in which a steam pumping engine is made to deliver mechanical power by discharging its output over an overshot wheel. Possibly the perpetual motion device was inspired by the idea of cutting out the steam pump and doing the business direct.

Needless to say, not one of the foregoing devices continued to work for even a limited period. So-called perpetual motion devices which *did* work were found upon examination to derive their power from sources of natural energy and not "created" power. One of these, over 100 years old, Fig. 4, actually used electricity, in itself derived from chemical action, to attract a suspended pith ball which was kept oscillating like a pendulum, it was claimed, for a number of years. The electrical generator here was a "dry pile" of metal discs separated by paper and assembled in a vertical glass tube closed by brass knobs. The pith ball was first attracted by the charged knob, and after acquiring a charge of like sign was repelled against an earthed conductor, discharged, and again attracted.

The most cursory examination of any of these devices revealed that they would not work "even on paper," let alone in substance. There is one "system" and one only that does work surprisingly well—"on paper." It is shown in

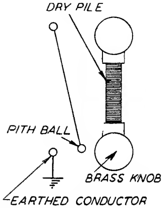


Fig. 4. Early electric "motor."

Fig. 5, and offers a fitting reply to any misguided individuals who still look to some "future discovery" for this mechanical "will-o'-the-wisp." In the wheel shown it will be observed that the upper weights are "nine pounders," which being inverted are converted into "six pounders," so that 27 lb. are always on top of their job in raising a mere 18 lb. Here we get, on paper, 50 per cent. more than we put in, a philosophy no more preposterous than that attached to any or all of the foregoing inventions.

A study of the above contraptions, which long ante-dated Heath Robinson, is worth while if it only enforces the hard stern fact that energy can neither be created nor destroyed. That action and reaction are opposite and equal and at best can only cancel each other out. In other words, "something for nothing" cannot be had even in

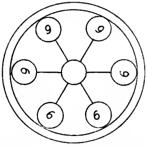


Fig. 5. Also a mechanical absurdity.

engineering or physics. Otherwise our world physical, intellectual and moral would have gone to pieces long ago, even if it ever came into existence at all. Seekers after "perpetual motion" were, to do them justice, good tryers, misguided but in the main honestly pursuing the unattainable, and ever in view of the ever-receding horizon and its mirage of promise.

Practical Letters

Model Speed Boats

DEAR SIR,—I would like to be allowed to second the appeal of Mons. G. M. Suzor for more details of model speed boats, but whereas he refers particularly to the boats which have been putting up very high performances on the other side of the Atlantic, I would suggest that in addition to these, there are many interesting boats much nearer home, about which information would be very welcome. In this category I include not only the boats which have made history, but also many of those among the great majority which have failed to do justice to the ingenuity and patience of the constructor.

In these difficult times, when it is almost impossible to run model speed boats at all, it is most important that interest in them should be maintained, and one of the best ways to do so is to keep enthusiasts well supplied with plenty of information, and also material for discussion. There are none of us so clever as to be able to dispense with any opportunity to improve our knowledge, and even this enforced idleness may be turned to ultimate profit if we use it to think over new problems and correct old mistakes.

As Mons. Suzor remarks, the war is bound to set back the English and French competitors very badly, and many of us may consider that all our efforts over a period of several years have been entirely wasted. As a matter of fact, the conditions for some time prior to the war made progress extremely difficult; much more so than is generally realised. This certainly applies to myself, and to the best of my belief, Mons. Suzor as well. When it becomes possible to re-commence racing activities, we shall have to face up to the fact that we are several miles an hour behind our American colleagues, but that is no reason why we should develop an inferiority complex and throw up the pursuit in disgust.

There are, from my point of view at any rate, two distinct aims in the development of model speed boats: the attainment of speed, and the attainment of knowledge; and I regard the latter as by far the more important. It is not very satisfactory to attain speed by purely hit-and-miss methods, without really knowing why; and it cannot be denied that exact knowledge on even the most elementary points of engine and hull design is still sadly lacking.

Now that most of us are prevented, by various circumstances, from running boats round the pole in races or trials, there is much that we can do in the way of independent testing of hulls and engines, and other research work. Mr. Hudson has offered to assist in the towing tests of hulls, and it is hoped that other readers will be able to get down seriously to the job of engine testing. Clubs might do worse than organise facilities for the bench testing of members' engines, and this form of activity would constitute quite an adequate substitute for the normal outdoor meetings which have had to be suspended during the war.

But one thing is most important—don't forget to let other readers know what you are doing. The great advantage of the international and inter-club meetings of recent years was the opportunity afforded for personal contact of the many "lone hands," and the discussion of intimate problems; don't allow these contacts to be broken, and the individual workers to drop back into complete isolation, while the pages of THE MODEL ENGINEER are available for the discussion of practical problems, and the ventilation of new ideas, successes and failures, or any news whatever relevant to the progress in which we are all interested.

Yours faithfully,

London, S.E. EDGAR T. WESTBURY.

Small Power-Brakes

DEAR SIR,—I was very much interested in the article on Brakes, by your contributor, "L.B.S.C.", in a recent issue of THE MODEL ENGINEER, and I look forward to more on the same subject.

Brakes have been sadly neglected. The provision of brakes is, to my mind, of equal importance to the provision of motive power, yet one finds many lines on which no brakes are provided—even on lines which cater for the public—some of which might be expected to come under the eagle eye of the Government Inspectors.

But disregarding these and confining one's attention to entirely private outfits—brakes are still a necessity. Nothing can be more humiliating than having to drift to a standstill when an emergency stop has been called for.

I know I shall be told "What about the reversing lever?" but the use of this for braking purposes usually results in still drifting to a standstill, but with locked driving wheels.

A very great deal can be accomplished by braking the locomotive as, of course, at least as much effort can be got out of it for stopping purposes, as can be got out of it for tractive purposes—the limit in both cases being the adhesive weight.

Taking the case of an all-wheels-coupled tank engine—in which the adhesive weight and total weight are the same. If the adhesive weight is sufficient to enable the tractive effort to produce a speed of, say, 6 m.p.h. in a distance of 20 ft., then the adhesive weight is obviously sufficient to enable the braking effort to stop the engine from a speed of 6 m.p.h. in a distance of 20 ft. under similar conditions; and this case, where adhesive weight and total weight are the same, is the worst case from the braking point of view—with any other type of engine, in which there are carrying wheels which can be braked in addition to the driving wheels, the adhesive weight for braking purposes is greater than the adhesive weight for tractive purposes, and the stopping distance will, therefore, be reduced. With a tender locomotive in which the engine-tender drawbar is of the inextensible unsprung variety usual on engines of 1 in. scale and under, it is quite easy to arrange the tender brakes to work in conjunction with those on the engine, whether these are operated by power or hand, and the resulting brake power is by no means to be despised, and will be a surprise to anyone who has not previously tried it.

Unless some artificial aids to adhesion—such as rack rails—are employed, it is impossible for the highest possible acceleration in any self-propelled vehicle to exceed the highest possible retardation—but it may equal it.

What acceleration or retardation you will actually get in any given case depends, of course, on the efficiency of your power plant, or your braking arrangements.

Yours faithfully,

London, S.W.16. W. B. HART.

Loco. Coal

Dear Sir,—The recent article written by Mr. V. B. Harrison on "Loco. Coal" in No. 2011 of The Model Engineer was to me of great interest, and I anticipated more comments on the subject. I noted only two, one by our old friend "L.B.S.C." and one by Mr. Proud. Experience with my 4-8-4 2½ gauge "Helen Long" type tank engine designed by "L.B.S.C.," and known locally as the "Brass Engine," may be of general interest. This locomotive was completed some three or four years ago, and to my way of thinking is a complete failure in as much that it was built to allow me to enjoy track days, and to participate in the running of my own locomotive in company of others, which I have not been able to do. I am able to raise steam fairly easily. I can obtain a good fire to look at, but there is just something wrong, the engine shows no liveliness, she does not push up the safety valve like the "Fayettes" and others do, she is just dead.

I have carried out many experiments and numerous alterations, and made many adjustments without any improvement. I have a box of various types of blast pipes. I've fitted up a testing stand in order to run her under close observation. The safety valves may just as well have been dummies for all the use they are. Much more could be written if space permitted. Why she has not been attacked with a large coal hammer and consigned to the garbage can I do not know. She is just lucky. The chassis and valve timing were inspected by "L.B.S.C." during a visit to England in 1932, and passed as correct, so I'm certain they are all right. During correspondence with another friend in London, I told him of my trouble and my disappointment, and I suggested that I intended altering the boiler. He wrote back and requested me to do nothing, as he was sending me a sample of coal to try. This arrived shortly afterwards, Mr. Cherms kindly loaned me his continuous track, and Mr. Henning kindly assisted me. Steam was raised in the ordinary way. The bag of sample coal which I noted was labelled "Graigola" was opened and a few shovelfuls popped on the fire. In a few minutes the safety valves lifted in a way they had never done before, and the engine seemed to spring into life, and seemed a different machine. Bill Henning said: "Now get on the track, George, and get her going and d——n well keep her going"! This I did; and what a ride! I was able to do lap after lap with no trouble. I found she only needed coal once every few laps of 250 ft. I did not have to be continuously fiddling with the fire. The safety valves lifted while running even with the pumps on; in fact, I could sit back, enjoy the ride, and obtain for the first time the thrills of driving a powerful miniature loco. of my own. The run was kept up all the afternoon until the coal was just about exhausted. I now know that there is nothing wrong with the locomotive, but that our local coal lacks sufficient thermal units for a firebox of that type. Better results may be obtained on local fuel with an expert driver such as "L.B.S.C.," but on local fuel as far as I'm concerned the loco. is still a failure. The "brass engine" is now greased down and packed away indefinitely until a more suitable boiler can be fitted of the "Fayette" type. Advice is sought as to the best way to go about it. I am quite willing to scrap one pair of driving wheels, and make her a 4-6-4 if a wide firebox can be fitted. "Graigola" is a fine fuel for "Helen Long" type locos. My best thanks to Mr. V. B. Harrison for his very interesting article. May we have more!

Yours faithfully,

Johannesburg. Geo. Perrem.

A History of "Tich Too"

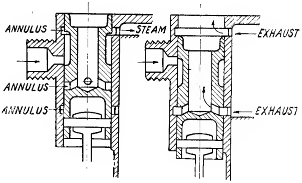
Dear Sir,—I would like to take this opportunity of adding a few notes concerning the engine of this boat, recently described. The description of this engine applies to the period at the latter end of the 1938 season and at that time, due to pump troubles, the engine was never severely tested to its limit. Since that time, however, I have produced a satisfactory water pump and put the engine through its paces on a bench rig by applying a prong brake and adjusting it to maintain an engine speed of about 3,000 r.p.m. with 50 lb. per square inch in petrol tank and lamp going all out.

The object of this letter is to convey the fact of excessive wear of the Corliss-type valves in the cylinder heads in spite of ample lubrication.

This wear is due to live steam pressure in the position when the steam port is covered immediately after cut-off. The valve is thrown bodily to the side of the valve chamber remote from the steam inlet and presses very heavily. Coupled with this action is the reciprocating effect of the valve-rod on the valve, which at high speeds is considerable.

If my memory serves me well, I think it was remarked once in The Model Engineer concerning the undue wear on a similar design of valve in Mr. Marsh's engine of *Sea Devil*. That valve was used only for exhaust, but the side pressure was there all the same—namely, due to the cylinder steam pressure between the time of exhaust closing and opening.

So that these troubles should not arise again now that I have found a satisfactory pump, the engine for *Tich Too* has been put on the shelf and a new one made embodying a completely steam-balanced piston valve. And here it is sketched (not to scale):—



All pressures are applied circumferentially by annular grooves. A feature of this valve is that steam which is normally released through uniflow ports is given a path through the lower end, and upwards through the centre, of the valve. At the commencement of exhaust the upper and lower ports are opening together, but the lower one closes, as in uniflow fashion, by being covered by the rising piston.

I have just completed a satisfactory bench test with the new engine embodying this valve and, so far, there are no complaints to report.

Yours faithfully,

Enfield. H. J. Turpin.